Investigation Report

Alky 2 Iso-butane Release

Date & Time the Incident Began: March 9th 2014 3:24PM

Investigation Start Date & Time: May 12th 2014 7:00am

Report Date: May 23rd 2014

Team: Nate Price – Investigator
Alex Englund – Investigator
Pat Towell - Facilitator
Jaylynn Jackson - Sponsor

Incident Summary:

On March 9th at approximately 3:24 PM Alky 2 experienced a release of approximately 5 bbls of isobutane to the atmosphere. The release immediately produced a large vapor cloud, creating an environment deemed as an immediate danger to life and health. The event lasted approximately 5 minutes, before operations successfully secured the source of the leak.

Situation Description:

On March 9th operations were attempting to purge isobutane from 12F107 (B contactor) to 12F114 (Acid Blow down Drum) via the bottom 4" drain header, in order to prepare the unit for turnaround status. To accomplish this task, operators partially opened the 4" vertical valve leading from the drain header to the acidic blowdown drum via the acidic flare header. As would be expected, operations noted that the associated line was frosting up as the isobutane passed through it. The motive force to move the material was the isobutane vapor pressure and a ¾" nitrogen hose lined up to 12F104, as 12F104 and 12F107 are connected. After a period of approximately 30 minutes, the line began to defrost. The production specialist (PS) was notified and the PS and operations team interpreted the defrosted as validating the system to be liquid isobutane free. At that time the PS instructed one of the operators (Operator 1) to isolate the line and check the 4" weak acid sewer (WAS) drain once the line was completely defrosted, in order to ensure that all material had been successfully purged; which the operator proceeded to do.

Because of a congestion of scaffolding and drain piping in the area the operator was forced to lean over the WAS valve in order to operate it. Operator 1 opened the drain line one turn and noted a small amount of acid and isobutane coming out of the drain. The operator then noted that the isobutane and acid had completely stopped and nitrogen began to flow from the drain. The operator continued to open the valve another turn, and waited as he noted the nitrogen flow had slowed further. The operator then opened the valve very quickly to approximately 30% open and waited approximately 30 seconds.

At that time an obstruction rapidly cleared the line and a large slug of liquid isobutane suddenly came out of the line. The slug of liquid isobutane reflected back from the drain and struck the operator in the face. The operator was temporarily blinded from the isobutane. A second nearby operator (Operator 2) heard the operator yelling, "I can't see!" and assisted the operator to the safety shower where he was washed off. A large vapor cloud began to form from the isobutane flowing from the open drain, creating an explosive atmosphere characterized as an immediate danger to life and health environment. The vapor cloud began to travel toward the South end of the unit.

A third operator in the area (Operator 3) tried to establish a flow of water to the leaking valve from hydrant 159 in order to clear a path to the valve; however the hydrant was stuck closed. While Operator 3

continued to work on getting hydrant 159 to work, Operator 2 notified non-essential personnel to clear the unit. At the same time operator 2 went to monitors 157 and 158 to attempt getting water to the leaking valve. However Operator 2 noted that both monitors 157 and 158 were broken. Operator 2 assessed that he was unable to help Operator 3 in getting hydrant 159 working, so he proceeded to the South side of the unit in order to spray down the vapor cloud in an attempt to "knock down the cloud and contain it to the unit." The attempt to spray down the vapor cloud was successful. At approximately the same time Operator 3 was finally able to get monitor 159 working and to get water on the leaking valve. Operator 1, who had now regained his sight, shut the leaking valve, stopping the flow of isobutane to the atmosphere, which contained the leak. The operators involved estimated the valve to have leaked for approximately 3 to 5 minutes to the atmosphere before it was contained.

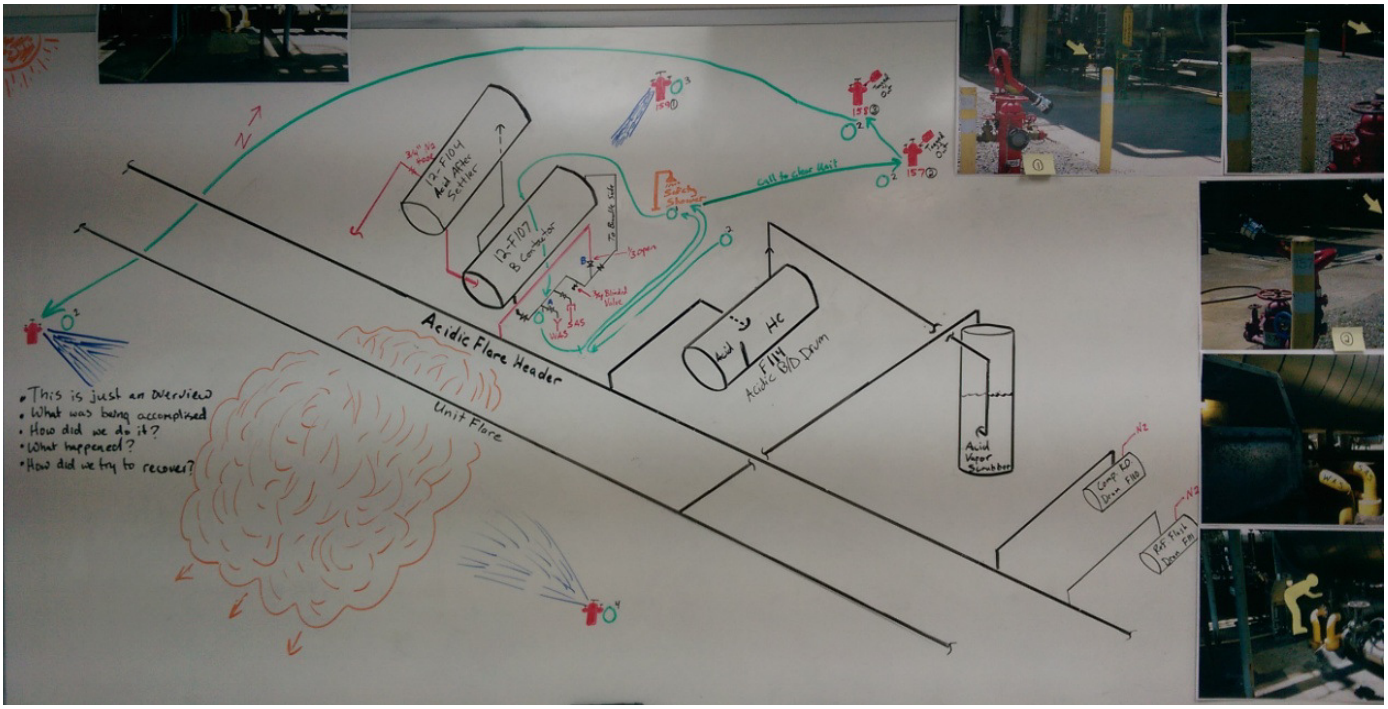

Figure 1- Isometric of affected system

Sequence of Events:

3/8/2014:

- Alky2 operators where in the process of shutting down the "B" Contactor as part of achieving T/A status.
- Nitrogen was lined up to the settler to aid in pushing out acid and Iso-butane.
- Operator stated that the "B" Contactor had a 2"-4" level of Light HC (isobutane) on top of the Acid.
- Operations started to push the Acid out of the "B" Contactor with liquid Iso-Butane.

3/9/2014:

- At approximately 6:30 AM operations began the process of vaporizing liquid isobutane to the B/D Drum & Acid Vapor Scrubber via Acidic flare header. This process of vaporizing flashes the isobutane for liquid to Vapor resulted in frost build up on the OD of the 4" Acidic Flare Header downstream of valve B.
- At approximately 12:30 the frost on the outside of the Acidic Flare Header began to defrost.
- Operations called for the production specialist (PS) to notify him of the change.

- The PS instructed the operators to open the 4" WAS drain valve once the defrosting was complete.
- At approximately 3:00 PM the line completely defrosted.
- Operations closed the valve to the Blowdown Drum and "cracked open" the 4" valve to the WAS and a small amount of hydrocarbon and acid came out.
- Isobutane flow stopped completely and nitrogen began to slow down. Operations opened the 4" valve a little more and waited approximately 2-3 minutes and nitrogen flow slowed.
- Operations then opened the 4" valve rapidly to 30% and waited 30 seconds.
- At ~3:24 PM a blockage within the 4" WAS drain suddenly let loose, and sprayed operator 1 in the face.
- Operator 3 went to monitor 159 and the valve was jammed.
- Operator 2 assisted operator 1 to the safety shower and began washing off.
- Operator 2 called for evacuation of Alky23 non-essential personnel.
- Operator 2 went to monitor 157 and 158 which were both broken.
- Operator 2 and operator 4 turned on fire monitors on the Southeast and Southwest side of the unit to contain the vapor cloud.
- Gas cloud began to change direction
- Operator 3 got monitor 159 valve working and began to spray down the 4"WAS drain valve.
- Operator 1 shut the 4" WAS drain valve and the leak stopped.

Iso Release Cause Timeline.pdf

Cause Analysis:

Why did Alky2 experience a light HC vapor cloud release of approximately 5 BBLS to the atmosphere on March 9th from 3:24PM to ~ 3:29PM?

1. There was a sufficient amount of light HC in the system.
   AND
2. There was a sufficient pressure in the system to push the HC out of the piping
   AND
3. The path from the contactor to the atmosphere suddenly cleared @ 3:24 PM for an approximate 5 minute period.
   AND
4. The flow path from the contactor to the atmosphere was sufficient to allow 5 BBLS of isobutane to escape to the atmosphere in a 5 minute period.

1. ***Why was there a sufficient amount of light HC in the system?***
   This is a normal situation for Alky2.
2. ***Why was there a sufficient pressure in the system to push the HC out of the piping?***
   There was sufficient pressure in the system due to N2 being connected to the system and there is also vapor pressure present from the isobutane. The nitrogen provides a motive force to move the acid/ isobutane from the contactor to the blowdown drum (F114). Another purpose of the nitrogen is to displace the HC vapors so the amount of HC to the atmosphere is limited when the vessel is opened to the atmosphere. Connecting Nitrogen is also a step in the shutdown procedure.
3. ***Why did a path from the contactor to the atmosphere suddenly clear @ 3:24 PM for an approximate 5 minute period?***
   Operations opened the 4" WAS drain valve in order to check for the presence of liquid isobutane. Once the valve was approximately 30% open an obstruction suddenly cleared the line and a large volume of liquid isobutane was released. A portion of the liquid isobutane was reflected blinding the operator. Of the three water sources required to suppress the vapors from the release; two were broken and one was jammed shut. The valve remained open until the operator regained his sight and water from the 159 fire monitor could be applied to the area. This took approximately 5 minutes.
4. ***Why was the flow path from the contactor to the atmosphere sufficient to allow 5 BBLS of isobutane to escape to the atmosphere in a 5 minute period?***

Operations chose to use the 4" WAS drain valve to check for liquid isobutane during the shutdown of the unit. Of the three available valves, operations perceived this valve as the one requiring the least amount of time and effort to use as well as being sufficient to accomplish the goal of checking for isobutane.

Observations, Insights, Conclusions:

Observation	The point where the flashing was sighted was 20' downstream of the valve where the release was. The valve where the release was, was clear of any frost. Operations and process both confirmed the system was free of water.
Insight	Without water or freezing conditions it is impossible to have a frozen ice ball.
Conclusion	The blockage was something other than ice

Observation	The statement says that the drain was a 3" (actually 4") valve. The majority of drains I have observed are ¾"-1" valves
Insight	This drain valve is significantly larger than a typical drain point.
Conclusion	The size of the valve may have been causal to the size of the release

Observation	Of the 3 available monitors in the area, one was seized and two of the monitors were broken. There were multiple tags on the broken monitors indicating they had been previously identified.
Insight	All available monitors were knowingly left in bad repair.
Conclusion	There is a belief system that accepts broken/dysfunctional monitors as an acceptable risk.

Observation	Operator thought that if the flare line is defrosted the B contactor was clear of product.
Insight	Closed systems can show false signs of being empty.
Conclusion	Frost on the outside of a pipe only shows change (pres. Dif.) of product inside of the pipe.

Observation	Scaffolding limited positioning to operate the drain valve.
Insight	Scaffolding was added to improve access to other valves and piping.
Conclusion	Adding scaffold to improve one job can affect other jobs.

Observation	Directions were to open the drain when the line was defrosted. Defrosting was considered an indication/process variable operations used to determine the system was iso-free
Insight	These methods are considered qualitative and subjective.

Conclusion	Shell uses variables for shutdown/decon that are qualitative/subjection.

Recommendations:

1. Consult with Process and Safety to evaluate the Alky 2 procedures 12ALKY2TA007, 12ALKY2NSD003 and 12ALKY2NSD004 in order to determine if the following change should be made: Replace wording directing operations to check for liquids/hydrocarbon by opening the 4" drain valve, with direction to use the "3/4" drain with hose attachment".	
What cause should be addressed?	The 12ALKY2TA007 procedure says to verify N2 is present at the 4" drain valve (i.e. liquid free)
Why? What would be the benefit?	The ¾" with attached hose would remove the operator from the direct path of the product if a release occurred. It would also limit the size of the release.
How? What would be the solution?	Use the ¾" drain with attached hose routed to the WAS in order to check for liquids/Nitrogen with the addition of a hose leading to the W.A.S.
How would this solution have been corrective, if it had been place?	The operator would have been further from the release. The quantity of the release would have been less if the ¾" connection was used.
If the solution is implemented, how would it prevent similar incidents in the future?	Operators checking for light ends materials would be farther away from the release point should a release occur. If there is a blockage in the future that suddenly clears, the quantity of a release would be much less with the use of the ¾" drain connection.
Systems of Safety	Training and Procedures
Action Plan:	**Who: Todd Ramsey** **What: Consult with Process and Safety to evaluate the Alky 2 procedures 12ALKY2TA007, 12ALKY2NSD003 and 12ALKY2NSD004 in order to determine if the following change should be made: Replace wording directing operations to check for liquids/hydrocarbon by opening the 4" drain valve, with direction to use the "3/4" drain with hose attachment".** **When: 5/31/2015**

2. Evaluate Alky 2 procedures with the Process Engineer to ensure all appropriate indications for liquid free condition are met before opening drains to atmosphere to check for liquids with high vapor pressures.	
What cause should be addressed?	The PS/Production team believed that defrosting was a sufficient indication that the line was empty of Isobutane.
Why? What would be the benefit?	There would be multiple indications to rely upon instead of a singular method such as checking for liquids at the drain.
How? What would be the solution?	Operations should evaluate procedures with the Process Engineering group in order to determine multiple methods for determining a system is liquid free.
How would this solution have been corrective, if it had been place?	This solution would have indicated that although the line had defrosted there was still significant pressure in the system alerting operations that there was liquid isobutene still present in the system.
If the solution is implemented, how would it prevent incidents in the future?	This would be another layer of protection to warn operators before opening the pressurized system to the atmosphere. Additional barriers adds protections to multiple scenarios.
Systems of Safety	Training and Procedures
Action Plan:	**Who: Todd Ramsey** **What: Evaluate Alky 2 procedures with the Process Engineer to ensure all appropriate indications for liquid free condition are met before opening drains to atmosphere to check for liquids with high vapor pressures.** **When: 5/31/2015**

3. Process to evaluate gaps in process fundamentals training and work with L&D department and operations to initiate training with ongoing competency for Alky 2 operators. Incorporate "red tag drills", "storm training".	
What cause should be addressed?	The PS/Production team believed that defrosting was a sufficient indication that the line was empty of Iso-butane.
Why? What would be the benefit?	Increasing operator knowledge/understanding around process fundamentals would promote effective trouble shooting and recognition of hazardous situations in process.
How? What would be the solution?	Ensure training modules are effective in teaching process fundamentals to new hires and ensuring current employees remain abreast on processes.
How would this solution have been corrective, if it had been in place?	If the understanding of hydraulics and vaporization curves were applied to this scenario, the operator would have gathered more process variables before checking the drain for liquids (i.e. pressure).

If the solution is implemented, how would it prevent similar incidents in the future?	A solid understanding of process variables would give operations a greater understanding of many scenarios, enabling them to more readily recognize process hazards.
Systems of Safety	Design and Engineering
Action Plan:	**Who: Michael Moore** **What: Process to evaluate gaps in process fundamentals training and work with L&D department and operations to initiate training with ongoing competency for Alky 2 operators. Incorporate "red tag drills", "storm training".** **When: To be completed before 6/30/2015**

4. Benchmark other sites within M to see what they do to check for hydrocarbons without venting to atmosphere when deconning Alky unit contactors.	
What cause should be addressed?	The operator was instructed by PS/Procedure to open the 4" WAS drain valve after piping defrosted
Why? What would be the benefit?	Routing the drain to a closed system would eliminate the possibility of a sudden release to atmosphere
How? What would be the solution?	Determine feasibility of using temporary decon piping during turnaround/shutdown decontamination phase to route the drain to a closed system (i.e. route to flare).
How would this solution have been corrective, if it had been place?	The release would have been to a closed system. Operator would not have been exposed to the product. No vapor cloud would have formed. Isobutane would have been recovered in FGR.
If the solution is implemented, how would it prevent incidents in the future?	Lines with similar conditions would be routed safely to a closed system.
Systems of Safety	Design and Engineering
Action Plan:	**Who: Mike Hutson** **What: Benchmark other sites within M to see what they do to check for hydrocarbons without venting to atmosphere when deconning Alky unit contactors.** **When: 12/22/2014**

Lateral Recommendations:

1. Who: Debbie Thompsen
What: Evaluate Alky 2 PPE requirements when deconing systems having a potential to vent process to atmosphere.
When: 5/30/2015

Who: Dave Hansen **What: Evaluate the need for the required operations checks of fire hydrants to include function test. Currently just a visual without operating the hydrant.** **When: 12/31/2014**
Who: Parrish Miller **What: Have Matt Jameson share the experience with this event through a plant video. Consider incorporating video in new employee on boarding training.** **When: 12/31/2014**
Who: Janita Aalto **What: Using the OTI project as the structure, consult process engineering to provide content and information to OTI to include in the newly updated modules.** **When: To be completed before 12/28/2017**

Communication & Auditing

Communication Plan	
Audit Plan	

Attachment 1: Cause Tree

Iso Release Cause Tree.pdf